



Basic Immunology Lecture – 2+3

Kidney Dialysis Techniques Department



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Organs of the Immune System & Mechanisms of Innate and Adaptive Immunity

Lecture Objectives:

By the end of this lecture, the student will be able to:

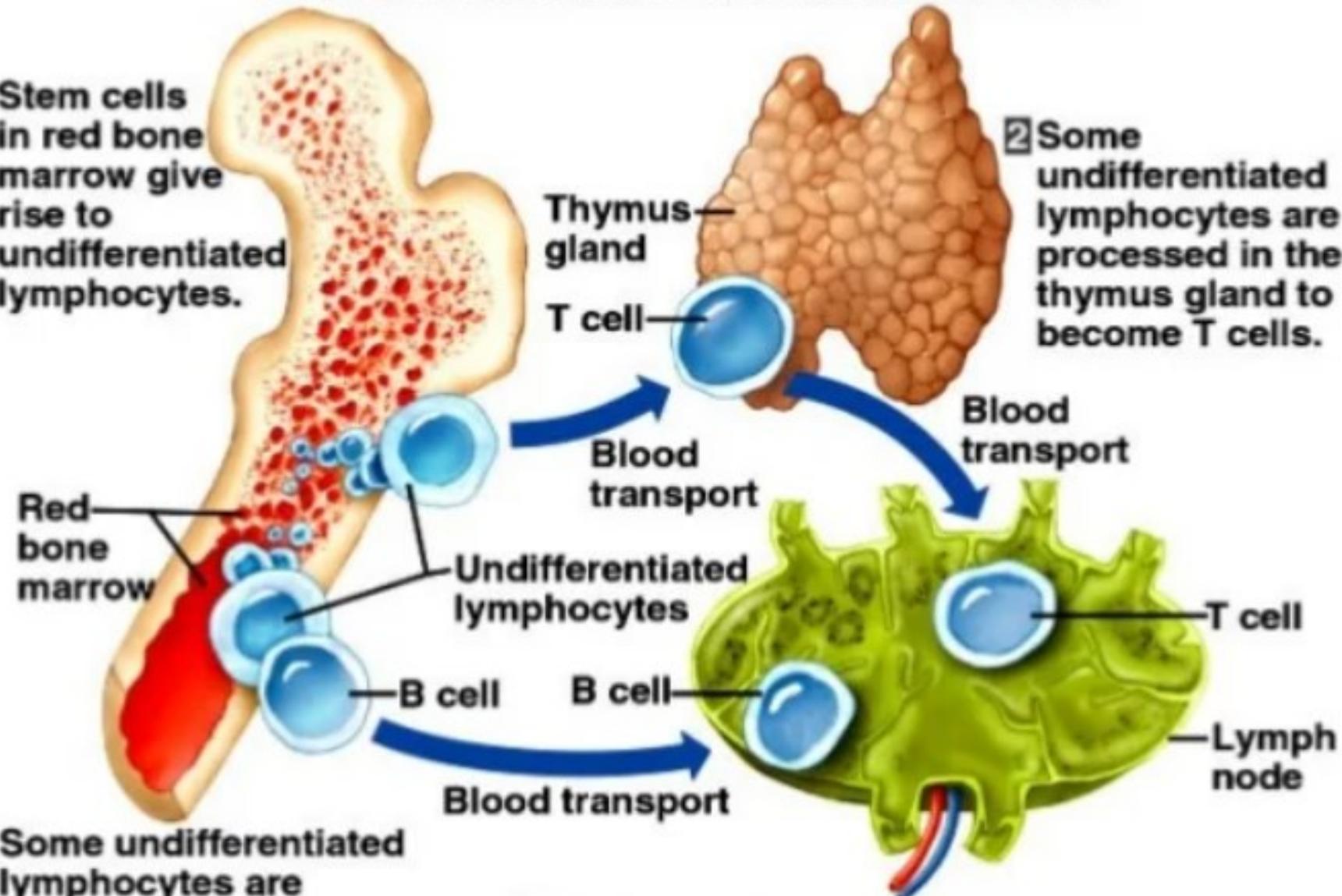
- 1- Identify the primary and secondary lymphoid organs.**
- 2- Explain the main function of each immune organ.**
- 3- Differentiate between the mechanisms of Innate and Adaptive immunity.**
- 4- Understand the importance of these concepts in the context of hemodialysis patients.**

1 Stem cells in red bone marrow give rise to undifferentiated lymphocytes.

2 Some undifferentiated lymphocytes are processed in the thymus gland to become T cells.

3 Some undifferentiated lymphocytes are processed, probably within the bone marrow, to become B cells.

4 Both T cells and B cells are transported through the blood to lymphatic organs, such as the lymph nodes, lymphatic ducts, and spleen.



Introduction

🌀 **Our immune system is a complex network of cells, tissues, and organs working together to defend the body against pathogens (germs, viruses, fungi or parasites) .**

🌀 **These mechanisms are housed within specific lymphoid organs throughout the body.**

🌀 **The immune system is divided into two main branches:**

▶ **Innate Immunity and Adaptive Immunity.**

Organs of the Immune System

The organs of the immune system are divided into two main types:

▶ **1. Primary (Central) Lymphoid Organs: Where immune cells are produced and mature.**

▶ **2. Secondary (Peripheral) Lymphoid Organs: Where immune cells gather and immune responses are initiated.**

Primary Lymphoid Organs

1- Bone Marrow:

- ▲ Located in the cavities of bones.**
- ▲ Function: It is the site of hematopoiesis, where all blood cells are produced, including white blood cells (lymphocytes, neutrophils, etc.).**
- ▲ B-lymphocytes (B cells) mature in the bone marrow.**

2- Thymus:

- ▲ Located behind the breastbone (sternum), in the anterior mediastinum. It is large in children and shrinks with age.**
- ▲ Function: It is the site where immature T-lymphocytes (T cells) migrate to mature and learn to distinguish self from non-self.**

Secondary Lymphoid Organs

1- Lymph Nodes:

♠ Small, bean-shaped structures located along lymphatic vessels in the neck, armpits, and groin.

♠ **Function:** They act as filters for lymph fluid. They contain B cells, T cells, and macrophages, and are key sites for initiating adaptive immune responses (often swell during infection).

2- Spleen:

Function:

♣ It acts as a filter for the blood. It removes old and damaged red blood cells,

♣ and contains immune cells that capture antigens from the blood to start an immune response.

3- Mucosa-Associated Lymphoid Tissue (MALT):

- ◆ Includes the **tonsils, appendix, and Peyer's patches** in the small intestine.
- ◆ **Function:** Protects the mucosal surfaces of the body (mouth, gut, respiratory tract), which are major entry points for pathogens

Mechanisms of Immunity

1- Innate Immunity (Natural/Native):

The first line of defense (Fast and Non-specific). There is no memory

2- Adaptive Immunity (Acquired/Specific):

The second line of defense (Slow initially, but Specific and has Memory).

Mechanism of Innate Immunity (Components)

1- Physical and Chemical Barriers:

- ▶ **Physical: Skin, mucous membranes, cilia in airways.**
- ▶ **Chemical: Stomach acid, tears (contain lysozyme enzyme), sweat.**

2- Cells (Cellular Innate Defense):

Macrophages, Neutrophils, Natural Killer (NK) Cells, Dendritic Cells.

Mechanism of Innate Immunity (Mechanisms)

1- Inflammation: A localized response to infection or injury; signs: redness, heat, swelling, pain.

2- Phagocytosis: The process of engulfing and destroying microbes by phagocytic cells.

3- Complement System: A group of proteins in the blood that "punch" holes in microbial cell membranes.

4- This response is rapid but not specific to a particular microbe.

Mechanism of Adaptive Immunity (Components)

Key Cells: Lymphocytes.

1- B-Lymphocytes:

▲ Differentiate into Plasma Cells that produce Antibodies (Immunoglobulins) .

2- T-Lymphocytes:

A- Helper T-cells (CD4+): Coordinate the immune response.

B- Cytotoxic T-cells (CD8+): Kill virus-infected or cancerous cells.

C- Memory T-cells: Retain antigen memory for a faster future response.

Mechanism of Adaptive Immunity (Characteristics & Types)

1- Specificity: Targets a specific antigen.

2- Memory: Faster and stronger response upon second exposure to the same microbe.

3- Humoral Immunity: Mediated by antibodies produced by B cells.

4- Cell-Mediated Immunity: Mediated by T cells.

Importance for Hemodialysis Patients

1- Immunodeficiency: Chronic kidney disease patients often have immune deficiency due to the effect of uremia on immune cell function (especially T cells).

2- Vaccine Response: Hemodialysis patients respond more poorly to vaccines (e.g., Hepatitis B), requiring larger or more frequent doses.

3- Chronic Inflammation: Dialysis itself can cause a state of chronic mild inflammation (activation of innate immunity) due to blood interaction with artificial membranes.

Summary

- ▶ **Primary lymphoid organs (Bone Marrow & Thymus) are the "training factories" for immune cells.**
- ▶ **Secondary lymphoid organs (Lymph Nodes & Spleen) are the "battlefields" where immune responses are launched.**
- ▶ **Innate immunity is the fast, non-specific first line of defense.**
- ▶ **Adaptive immunity is the slow, specific, and powerful memory response.**
- ▶ **These two systems work together in an integrated manner to protect the body.**

Review Questions

- 1- What is the main functional difference between the bone marrow and the thymus?**
- 2- Where are B cells and T cells found in abundance in a lymph node?**
- 3- Name three types of cells involved in innate immunity.**
- 4- What is the main component of humoral adaptive immunity?**
- 5- Why might a dialysis patient have a poor response to the Hepatitis B vaccine?**

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